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The air in the testing chamber must be analyzed for traces of helium gas by means of a mass spectrograph. The test must be conducted for a period of time sufficient to evacuate the chamber and to determine if there is leakage into or out of the packaging. If helium gas is detected, the leaking packaging must be automatically separated from non-leaking drums and the leaking area determined according to the method prescribed in §178.604(d) of this subchapter. A packaging passes the test if there is no leakage of helium.

(2) *Pressure differential test.* The packaging shall be restrained while either pressure or a vacuum is applied internally. The packaging must be pressurized to the pressure required by §178.604(e) of this subchapter for the appropriate packing group. The method of restraint must not affect the results of the test. The test must be conducted for a period of time sufficient to appropriately pressurize or evacuate the interior of the packaging and to determine if there is leakage into or out of the packaging. A packaging passes the pressure differential test if there is no change in measured internal pressure.

(3) *Solution over seams.* The packaging must be restrained while an internal air pressure is applied; the method of restraint may not affect the results of the test. The exterior surface of all seams and welds must be coated with a solution of soap suds or a water and oil mixture. The test must be conducted for a period of time sufficient to pressurize the interior of the packaging to the specified air pressure and to determine if there is leakage of air from the packaging. A packaging passes the test if there is no leakage of air from the packaging.

(4) *Solution over partial seams test.* For other than design qualification testing, the following test may be used for metal drums: The packaging must be restrained while an internal air pressure of 48 kPa (7.0 psig) is applied; the method of restraint may not affect the results of the test. The packaging must be coated with a soap solution over the entire side seam and a distance of not less than eight inches on each side of the side seam along the chime seam(s). The test must be conducted for a period of time sufficient to pressurize the interior of the packaging to the specified air pressure and to determine if there is leakage of air from the packaging. A packaging passes the test if there is no leakage of air from the packaging. Chime cuts must be made on the initial drum at the beginning of each production run and on the initial drum after any adjustment to the chime seamer. Chime cuts must be maintained on file in date order for not less than six months and be made available to a rep-

resentative of the Department of Transportation on request.

[Amdt. 178–97, 55 FR 52728, Dec. 21, 1990, as amended at 56 FR 66287, Dec. 20, 1991; 57 FR 45466, Oct. 1, 1992]

APPENDIX C TO PART 178—NOMINAL AND MINIMUM THICKNESSES OF STEEL DRUMS AND JERRICANS

For each listed packaging capacity, the following table compares the ISO 3574 (IBR, see §171.7 of this subchapter) nominal thickness with the corresponding ISO 3574 minimum thickness.

Maximum capacity (L)	ISO nominal (mm)	Corresponding ISO minimum (mm)
20 .....	0.7	0.63
30 .....	0.8	0.73
40 .....	0.8	0.73
60 .....	1.0	0.92
120 .....	1.0	0.92
220 .....	1.0	0.92
450 .....	1.9	1.77

[Amdt. 178–106, 59 FR 67522, Dec. 29, 1994, as amended at 68 FR 75758, Dec. 31, 2003]

APPENDIX D TO PART 178—THERMAL RESISTANCE TEST

1. *Scope.* This test method evaluates the thermal resistance capabilities of a compressed oxygen generator and the outer packaging for a cylinder of compressed oxygen or other oxidizing gas and an oxygen generator. When exposed to a temperature of 205 °C (400 °F) for a period of not less than three hours, the outer surface of the cylinder may not exceed a temperature of 93 °C (199 °F) and the oxygen generator must not actuate.

2. *Apparatus.*

2.1 *Test Oven.* The oven must be large enough in size to fully house the test outer package without clearance problems. The test oven must be capable of maintaining a minimum steady state temperature of 205 °C (400 °F).

2.2 *Thermocouples.* At least three thermocouples must be used to monitor the temperature inside the oven and an additional three thermocouples must be used to monitor the temperature of the cylinder. The thermocouples must be 1/16 inch, ceramic packed, metal sheathed, type K (Chromel-Alumel), grounded junction with a nominal 30 American wire gauge (AWG) size conductor. The thermocouples measuring the temperature inside the oven must be placed at varying heights to ensure even temperature and proper heat-soak conditions. For

the thermocouples measuring the temperature of the cylinder: (1) Two of them must be placed on the outer cylinder side wall at approximately 2 inches (5 cm) from the top and bottom shoulders of the cylinder; and (2) one must be placed on the cylinder valve body near the pressure relief device. Alternatively, the thermocouples may be replaced with other devices such as a remote temperature sensor, metal fuse on the valve, or coated wax, provided the device is tested and the test report is retained for verification. Under this alternative, it is permissible to record the highest temperature to which the cylinder is subjected instead of temperature measurements in intervals of not more than five (5) minutes.

**2.3 Instrumentation.** A calibrated recording device or a computerized data acquisition system with an appropriate range should be provided to measure and record the outputs of the thermocouples.

### 3. Test Specimen.

**3.1 Specimen Configuration.** Each outer package material type and design must be tested, including any features such as handles, latches, fastening systems, etc., that may compromise the ability of the outer package to provide thermal protection.

**3.2 Test Specimen Mounting.** The tested outer package must be supported at the four corners using fire brick or other suitable means. The bottom surface of the outer package must be exposed to allow exposure to heat.

### 4. Preparation for Testing.

**4.1** It is recommended that the cylinder be closed at ambient temperature and configured as when filled with a valve and pressure relief device. The oxygen generator must be filled with an oxidizing agent and may be tested with or without packaging.

**4.2** Place the package or generator onto supporting bricks or a stand inside the test oven in such a manner to ensure even temperature flow.

### 5. Test Procedure.

**5.1** Close oven door and check for proper reading on thermocouples.

**5.2** Raise the temperature of the oven to a minimum temperature of 205 °C  $\pm$  2 °C (400 °F  $\pm$  5 °F). Maintain a minimum oven temperature of 205 °C  $\pm$  2 °C (400 °F  $\pm$  5 °F) for at least three hours. Exposure time begins when the oven steady state temperature reaches a minimum of 205 °C  $\pm$  2 °C (400 °F  $\pm$  5 °F).

**5.3** At the conclusion of the three-hour period, the outer package may be removed from the oven and allowed to cool naturally.

### 6. Recordkeeping.

**6.1** Record a complete description of the material being tested, including the manufacturer, size of cylinder, etc.

**6.2** Record any observations regarding the behavior of the test specimen during exposure, such as smoke production,

delamination, resin ignition, and time of occurrence of each event.

**6.3** Record the temperature and time history of the cylinder temperature during the entire test for each thermocouple location. Temperature measurements must be recorded at intervals of not more than five (5) minutes. Record the maximum temperatures achieved at all three thermocouple locations and the corresponding time.

### 7. Requirements.

**7.1** For a cylinder, the outer package must provide adequate protection such that the outer surface of the cylinder and valve does not exceed a temperature of 93 °C (199 °F) at any of the three points where the thermocouples are located.

**7.2** For an oxygen generator, the generator must not actuate.

[72 FR 4457, Jan. 31, 2008, as amended at 72 FR 55099, Sept. 28, 2007]

## APPENDIX E TO PART 178—FLAME PENETRATION RESISTANCE TEST

(a) *Criteria for Acceptance.* (1) At least three specimens of the outer packaging materials must be tested;

(2) Each test must be conducted on a flat 16 inch x 24 inch test specimen mounted in the horizontal ceiling position of the test apparatus to represent the outer packaging design;

(3) Testing must be conducted on all design features (latches, seams, hinges, etc.) affecting the ability of the outer packaging to safely prevent the passage of fire in the horizontal ceiling position; and

(4) There must be no flame penetration of any specimen within 5 minutes after application of the flame source and the maximum allowable temperature at a point 4 inches above the test specimen, centered over the burner cone, must not exceed 205 °C (400 °F).

(b) *Summary of Method.* This method provides a laboratory test procedure for measuring the capability of cargo compartment lining materials to resist flame penetration with a 2 gallon per hour (GPH) #2 Grade kerosene or equivalent burner fire source. Ceiling and sidewall liner panels may be tested individually provided a baffle is used to simulate the missing panel. Any specimen that passes the test as a ceiling liner panel may be used as a sidewall liner panel.

(c) *Test Specimens.* (1) The specimen to be tested must measure 16  $\pm$  1/8 inches (406  $\pm$  3 mm) by 24  $\pm$  1/8 inches (610  $\pm$  3 mm).

(2) The specimens must be conditioned at 70 °F.  $\pm$  5 °F. (21 °C.  $\pm$  2 °C.) and 55%  $\pm$  5% humidity for at least 24 hours before testing.

(d) *Test Apparatus.* The arrangement of the test apparatus must include the components described in this section. Minor details of the apparatus may vary, depending on the model of the burner used.